

WHAT IS CLAIMED IS:

1     1.     A method of punching a through hole at a metal board, comprising  
2     steps of:  
3         providing an upper die and a lower die;  
4         forming an unpenetrating hole at an upper face of the metal board  
5     with the upper die, so that a protrusion is formed on a lower face of the metal  
6     board at a portion corresponding to the unpenetrating hole;  
7         forming a flat portion on the protrusion with the lower die; and  
8         punching the unpenetrating hole with the upper die while supporting  
9     the flat portion with the lower die to form the through hole.

1     2.     The punching method as set forth in claim 1, wherein a bottom of the  
2     unpenetrating hole is supported by the upper die when the flat portion is  
3     formed.

1     3.     The punching method as set forth in claim 1, wherein the upper face  
2     of the metal board is supported by the upper die when the flat portion is  
3     formed.

1     4.     The punching method as set forth in claim 1, wherein the upper die  
2     comprises a first upper die which forms the unpenetrating hole and a second  
3     upper die which forms the through hole.

1 5. The punching method as set forth in claim 1, wherein a draft is  
2 provided on the upper die.

1 6. The punching method as set forth in claim 1, wherein the lower die is  
2 configured such that the flat portion is annularly formed.

1 7. The punching method as set forth in claim 1, wherein the lower die  
2 comprises a first lower die which forms the flat portion and a second lower die  
3 which supports the flat portion when the through hole is formed.

1 8. The punching method as set forth in claim 1, wherein the upper die  
2 and the lower die are configured such that a plurality of through holes are  
3 simultaneously punched.

1 9. The punching method as set forth in claim 8, wherein the through  
2 holes are arranged with an interval of 0.3mm or less.

1 10. The punching method as set forth in claim 1, wherein a maximum  
2 width dimension of the through hole is 0.2mm or less.

1 11. The punching method as set forth in claim 1, wherein a ratio of a  
2 penetrating length of the through hole with respect to a maximum width  
3 dimension of the through hole is 0.5 or more.

1     12.     The punching method as set forth in claim 1, wherein the through hole  
2     is formed at a portion of the metal board which has been subjected to a plastic  
3     working.

1     13.     The punching method as set forth in claim 1, further comprising a step  
2     of removing burrs formed on the metal board.

1     14.     The punching method as set forth in claim 1, wherein the through hole  
2     has a rectangular cross section.

1     15.     The punching method as set forth in claim 1, wherein the through hole  
2     has a circular cross section.

1     16.     The punching method as set forth in claim 1, wherein the metal board  
2     is comprised of nickel.

1     17.     A method of manufacturing a liquid ejection head, comprising steps  
2     of:

3             providing a metal board;

4             subjecting the metal board to a plastic working to form a recess on a  
5     first face of the metal board;

6             punching a through hole communicating the recess and a second  
7     face of the metal board, by the punching method as set forth in claim 1;

8             attaching a metallic nozzle plate formed with a nozzle, onto the  
9     second face of the metal board, such that the nozzle is communicated with the

10 through hole; and

11 attaching a metallic sealing plate formed with a liquid supply hole,  
12 onto the first face of the metal board so as to seal the recess, so that pressure  
13 generated in liquid supplied to the recess via the liquid supply hole ejects a  
14 liquid droplet from the nozzle via the through hole.

1 18. A punching apparatus, comprising:

2 an upper die, operable to form an unpenetrating hole at an upper face  
3 of a metal board so that a protrusion is formed on a lower face of the metal  
4 board at a portion corresponding to the unpenetrating hole; and

5 a lower die, operable to form a flat portion on the protrusion,

6 wherein the upper die is operable to punch the unpenetrating hole  
7 while the lower die supports the flat portion to form a through hole at the metal  
8 board.

1 19. The punching apparatus as set forth in claim 18, wherein the upper  
2 die supports a bottom of the unpenetrating hole when the flat portion is formed.

1 20. The punching apparatus as set forth in claim 18, wherein the upper  
2 die supports the upper face of the metal board when the flat portion is formed.

1 21. The punching apparatus as set forth in claim 18, wherein the upper  
2 die comprises a first upper die which forms the unpenetrating hole and a  
3 second upper die which forms the through hole.

1     22.     The punching apparatus as set forth in claim 21, wherein a width of  
2     the first upper die is greater than a width of the second upper die.

1     23.     The punching apparatus as set forth in claim 21, wherein the upper  
2     die further comprises a third upper die which supports a bottom of the  
3     unpenetrating hole when the flat portion is formed.

1     24.     The punching apparatus as set forth in claim 23, wherein a width of  
2     the third upper die is smaller than a width of the first upper die.

1     25.     The punching apparatus as set forth in claim 18, wherein a draft is  
2     provided on the upper die.

1     26.     The punching apparatus as set forth in claim 18, wherein the lower  
2     die is configured such that the flat portion is formed annularly.

1     27.     The punching apparatus as set forth in claim 18, wherein:  
2             the lower die comprises a first lower die which forms the flat portion  
3     and a second die which supports the flat portion when the through hole is  
4     formed;

5             the first lower die is formed with a first working hole which defines the  
6     flat portion, and the second lower die is formed with a second working hole  
7     which defines a portion for supporting the flat portion; and

8             a size of the second working hole is greater than the first working  
9     hole.

1     28.     The punching apparatus as set forth in claim 27, wherein:  
2             the lower die further comprises a third lower die which supports the  
3     lower face of the metal board when the unpenetrating hole is formed;  
4             the third lower die is formed with a third working hole which defines a  
5     portion at which the protrusion is formed; and  
6             a size of the third working hole is greater than the size of the second  
7     working hole.

1     29.     The punching apparatus as set forth in claim 18, wherein the upper  
2     die and the lower die are configured such that a plurality of through holes are  
3     simultaneously punched.